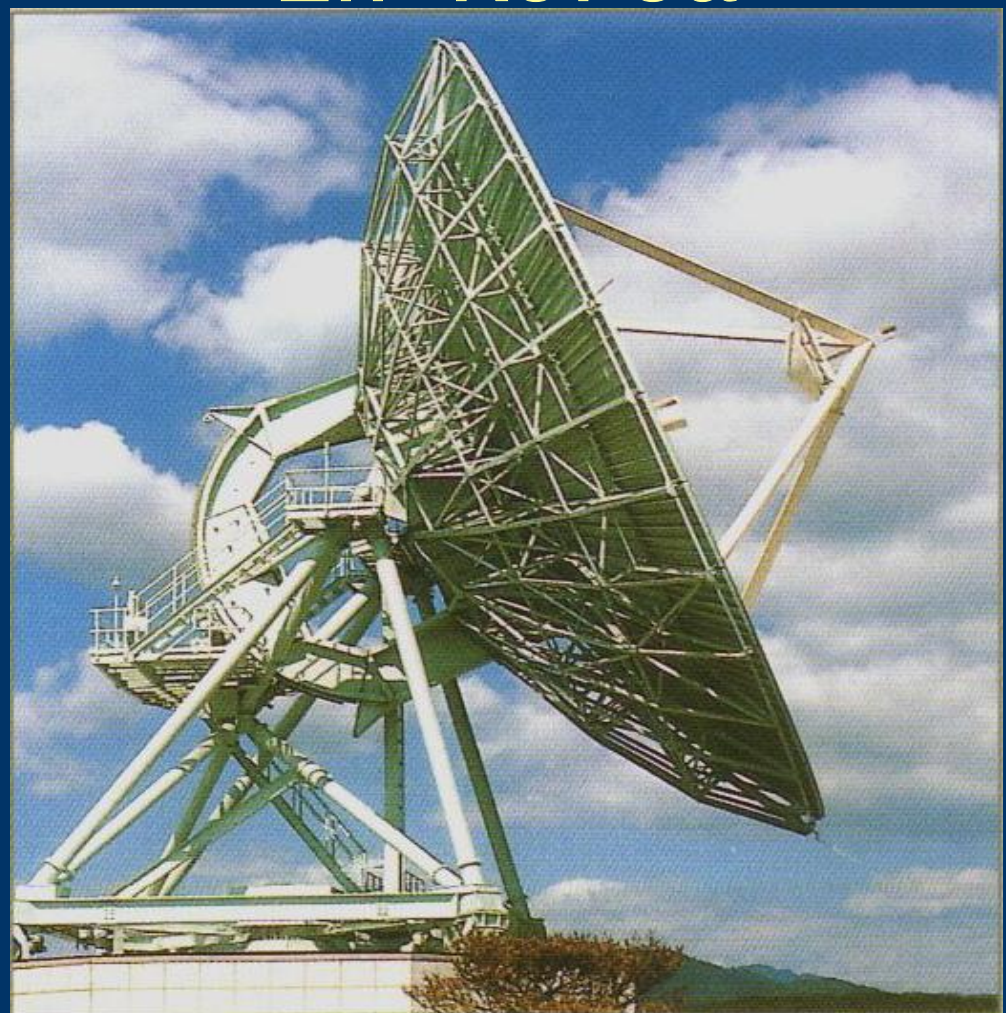
A conceptual Design of a Geodetic VLBI Antenna in Korea



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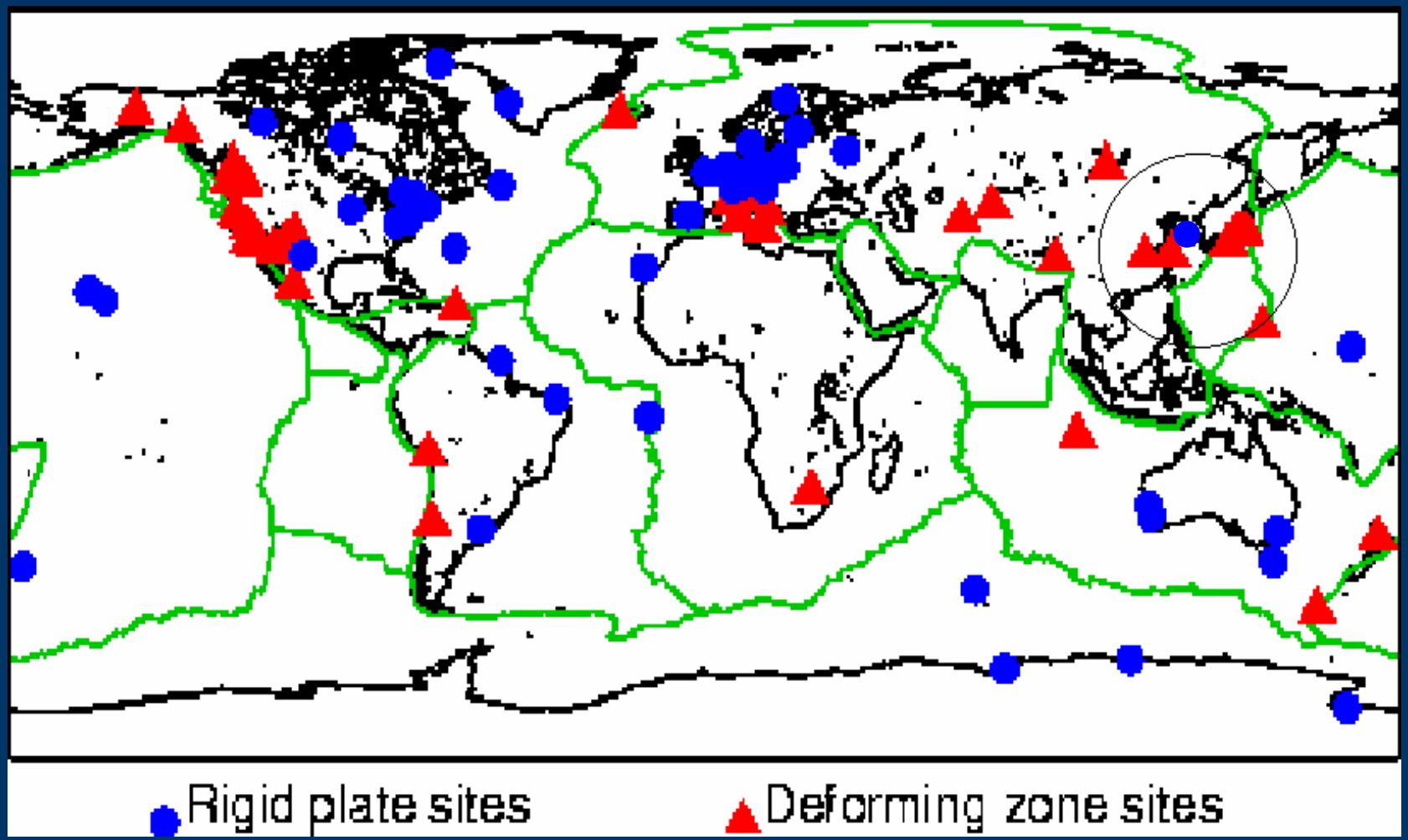
Purpose

To participate in international geodetic VLBI observations

To maintain the Korean geodetic origin precisely in ITRF

=> National Geographic Information Institute in Suwon
(1995年 韓·日 VLBI Observation)

(ITRF : International Terrestrial Reference Frame)



< Blue points mean the "Stable" Stations
used for defining ITRF by IERS>

· Korean Peninsula => relatively stable

(IERS : International Earth Rotation and Reference System Service)

Functions of a Geodetic VLBI Antenna

·Establish a new geodetic reference point on the Korean Peninsula

·Define movement and boundaries of the tectonic plates in East Asia

·Monitor internal deformation in the Korean Peninsula

·Collaborate with Astronomical VLBI observation

KVN : Korea VLBI Network
VERA : VLBI Exploration of Radio Astrometry

Conceptual Design of Antenna

Sensitivity

Those sources with accurate, reliable positions that could be used to orient ICRF axes

Source flux density

ICRF Defining Sources(212)

ICRF Extended Sources(667)

< 8GHz correlated flux density values from VLBA Calibrator Survey Catalog>

Expected source flux densities at higher frequencies (Unit : Jy)

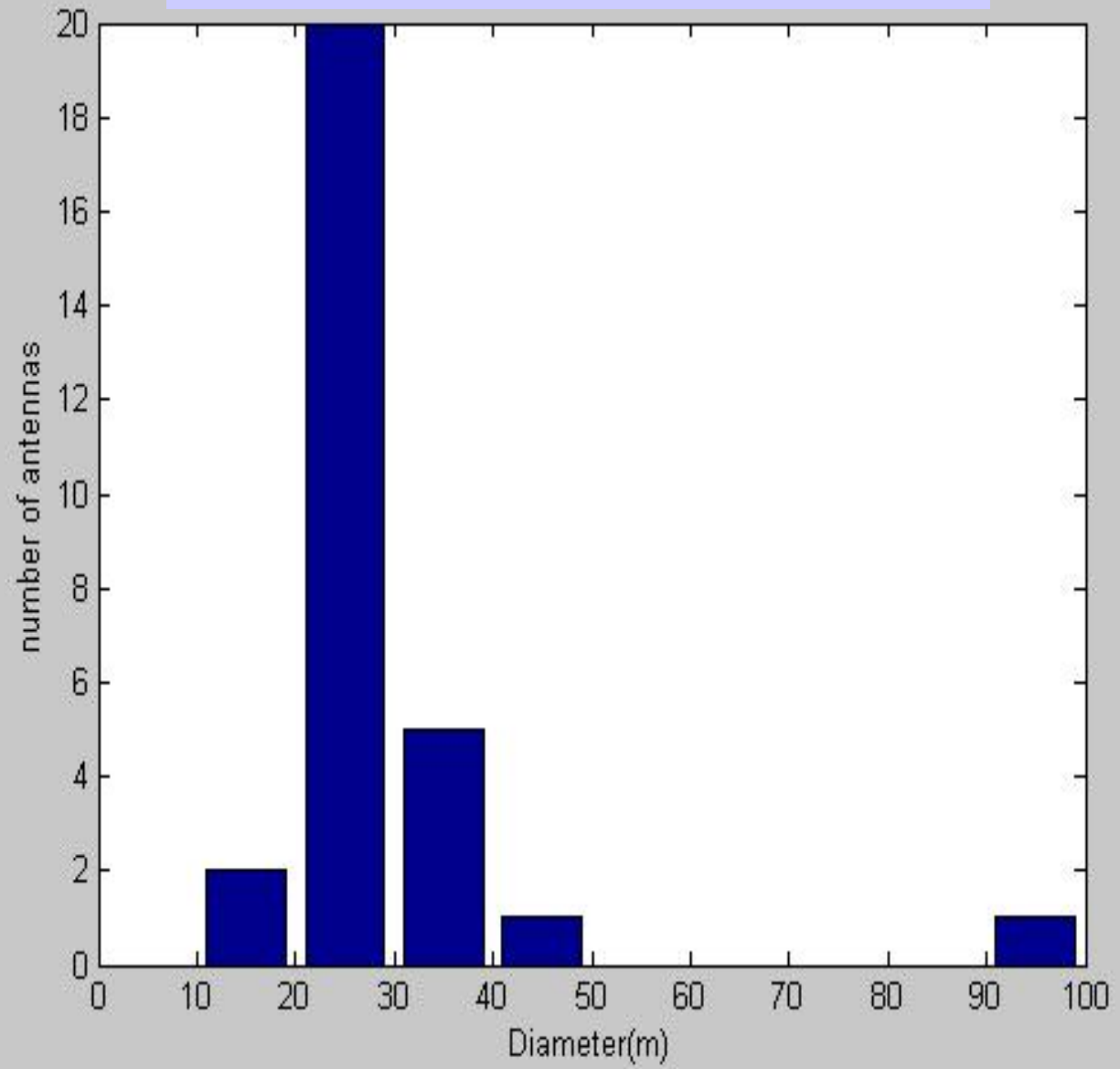
fre. \ α	0	0.3	0.5
8GHz	0.1 -- 2	0.1 -- 2	0.1 -- 2
22GHz	0.1 -- 2	0.074 -- 1.476	0.060 -- 1.206
32GHz	0.1 -- 2	0.066 -- 1.320	0.050 -- 1.000
43GHz	0.1 -- 2	0.060 -- 1.208	0.0431 -- 0.863

$$S_\nu \propto \nu^{-\alpha}$$

(ICRF : International Celestial Reference Frame)

Geodetic VLBI Antennas in the world

< Histogram of VLBI Antenna Diameter >



Map Image

SUWON(20m level) — FORTLEZA(14.2m ,Brazil)

S/N > 7 for VLBI in general

$$S/N = \eta_c \frac{S_\nu}{\sqrt{SEFD_1 SEFD_2}} \sqrt{2B\tau_a}$$

$$SEFD = \frac{2kT_s}{A_e} \quad , \quad A_e = \frac{\eta_A L^2 \pi}{4}$$

$$(\ k = 1.381 \times 10^{-23} J/K \ )$$

assume

$\eta_A = 0.5$
$\eta_c = 0.88$
$T_s = 120K$
$B = 256MHz$
$\tau_a = 200\sec$

The value of weakest observing source is adopted as 0.1Jy !

(SEFD : System Equivalent Flux Density)

$L_1 = 20m$, $L_2 = 14.2m$
$SEFD_1 = 2.11 \times 10^3 \ Jy$
$SEFD_2 = 4.18 \times 10^3 \ Jy$ ($1Jy = 10^{-26} Wm^{-2}Hz^{-1}$)

$S/N = 9.48 > 7$

SUWON(20m level) — Mobile Antenna(4m)

Assume

Diameter of mobile antenna = 4 m

Same conditions before

$$SEFD_m = \frac{2kT_{sm}}{A_{em}} = 5.2750 \times 10^4 \, Jy$$

For 30 brightest defining and extended sources

Minimun flux density = 0.6342 Jy (J0808+4950)

Upper limit for the $SEFD_s$ of Suwon antenna required

for observing the above minimum flux density source is $1.230 \times 10^4 Jy$

SEFD of the 20m antenna was $2.11 \times 10^3 \, Jy.$

Much better than above value

————> We can use a small mobile antenna for geodetic VLBI observations.

Receiving Frequency

KVN:Korea VLBI Network
VERA:VLBI Exploration of Radio Astrometry

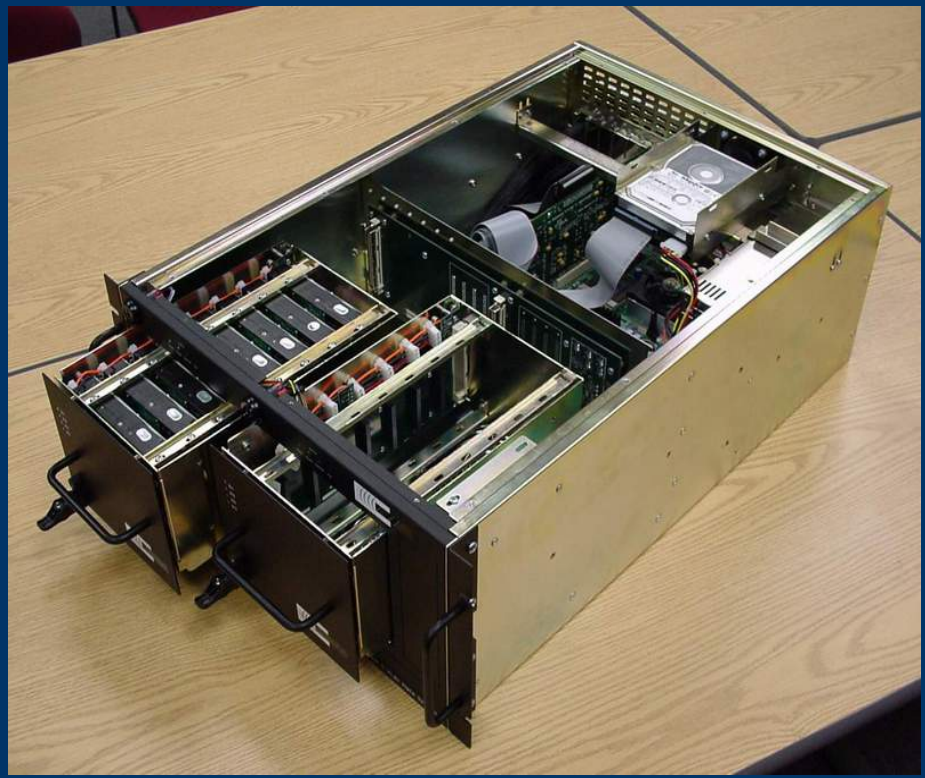
2/8GHz for Geodetic VLBI
—> may be shifted to 22GHz or 32GHz level

To avoid artificial interference
(e.g. mobile phone)

To cooperate with KVN and VERA
22GHz & 43GHz are desirable.

Recording System

·Compatibility with
  international observations
 & astronomical stations(KVN , VERA etc.)
—> VSI(VLBI Standard Interface)
·Extension to e-VLBI via communication network



< Mark V >

< K 5 >

Basic Specifications of the new geodetic VLBI antenna

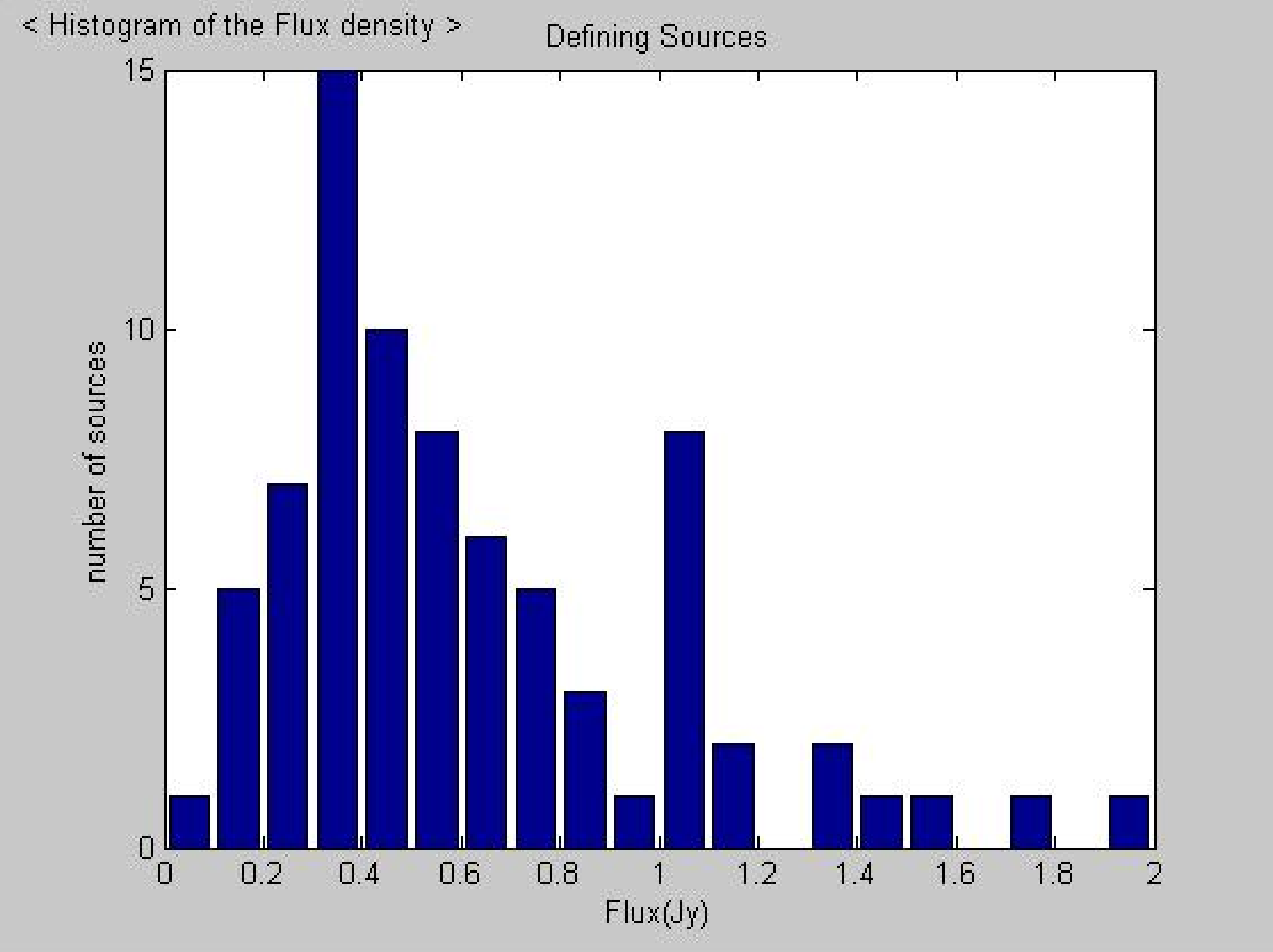
— 20m class diameter
— 2 -- 32GHz Receiving Band (43GHz desirable)
— Mark - V or Equivalent Recording System
  with speed ≥ 1Gbps
— VSI(VLBI Standard Interface)

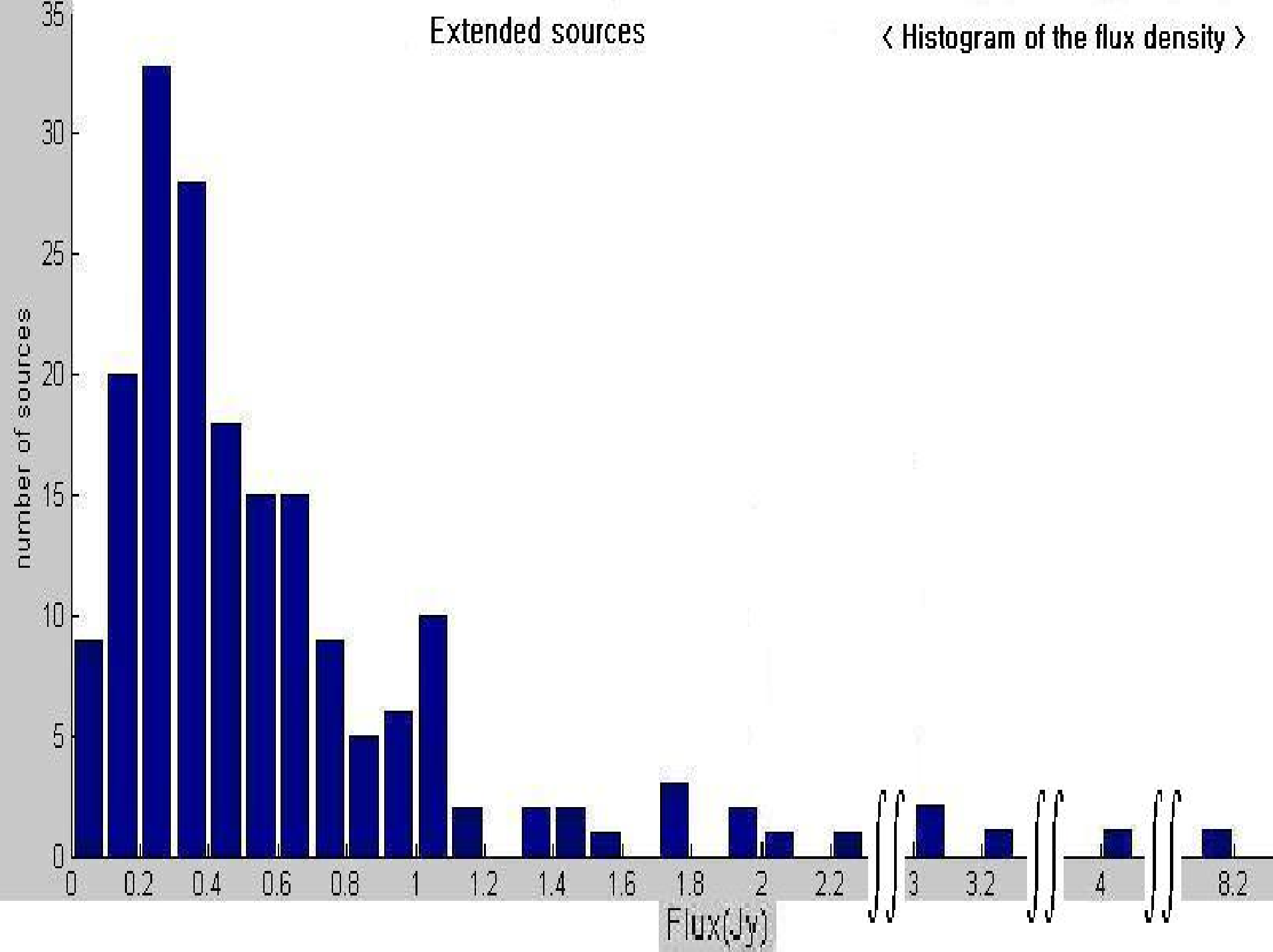
As a Candidate antenna (Made in Korea)

Az-El mount
21m diameter
0.5mm rms surface accuracy (good enough at 22 and 32 GHz)
Almost full motion(5° -- 90° elevation ,±170° azimuth)
C - band(3.625 GHz -- 4.2 GHz)
0.3°/sec slew rate

Image of the Antenna


Ny Alesund
Gilmore Creek
Yellowknife
Onsala
FFI
Svetloe
IAA
JIVE
GIUB
AIStPbU
BKG
MAO
FGS(BKG,GIUB)
Wettzell
Paris
DGFI
Algonquin
Canadian VLBI
Westford
Haystack
Bordeaux
CNIG
Medicina
Simeiz
GGAO
IEEC
Yebes
Matera
Nanshan
Mizusawa
Tsukuba
Kashima34
Green Bank
GSFC
Noto
Seshan
CRL
JPL
USNO
Shanghai
Kashima 11
Kokee Park
NEOS
Miura
Koganei
Tateyama
Fortaleza
Hartebeesthoek
Network Station
Operation Center
Correlator
Data Center
Analysis Center
Technology Development Center
Coordinating Center
O'Higgins
Syowa


< Histogram of the Flux density >
Defining Sources
number of sources
Flux(Jy)
0
5
10
15
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2


Extended sources
〈 Histogram of the flux density 〉
number of sources
0
5
10
15
20
25
30
35
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
2.2
3
3.2
4
8.2
Flux(Jy)